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Evaluation of the Performance of the Community Rainforest Reforestation Program in North Queensland, Australia

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The Community Rainforest Reforestation Program (CRRP) in north Queensland, Australia, was a multi-faceted experiment in facilitating farm forestry. It was motivated in part by the World Heritage listing of the Wet Tropics of Queensland rainforests, which removed a large resource from the timber industry. Survey results indicate that some landholders have applied high-quality silvicultural management to their stands with a view to timber production, while others have been more interested in wildlife habitat and other non-wood benefits. Although not necessarily a success in terms of its stated goals, the program can be credited with a number of achievements. It yielded valuable experience in growing native tree species, job training for young unemployed people, and collaboration between Federal, State and local government in forest industry development. The program generated positive environmental outcomes and lessons for future timber and environmental planting programs on private lands. While the area planted and quantity of timber produced will fall far short of initial expectations, and some limitations arose with the job training activities, it nevertheless appears to have been a worthwhile project.

Keywords: Community forestry, multiple-use forestry, cabinet timbers, rainforest species

INTRODUCTION

North Queensland has a long history of timber harvesting and marketing of rainforest cabinet timbers, as reflected for example in the book about harvesting red cedar titled *Red Gold: The Tree that Built a Nation* (Vader 2002). A large industry operated in the milling of red cedar and other high-value native species, for which there was a well-functioning supply chain, with much of the timber sent to southern markets. The allowable cut, which in the late 1940s reached 350,000 m^3/year, was progressively reduced, and the industry contracted (e.g. Lamb *et al*. 2001, Harrison

et al. 2003). World Heritage listing of the Wet Tropics of Queensland rainforests in 1988 caused a sudden cessation of timber extraction from most of the tropical rainforest area. Some timber harvesting continued from approximately 13,000 ha of government-owned softwood plantations, native forests on private land, and small areas of private plantations. However, forestry in north Queensland has been a case of a declining industry, with loss of infrastructure and the skills base. One softwood mill of 25,000 m^3 and a few small hardwood mills continue to operate.

Against this background, attempts have been made to revive the north Queensland timber industry, and various reforestation programs have been initiated, including the Community Rainforest Reforestation Program (CRRP), the Plantation Joint Venture Scheme (PJVS) of the Department of Primary Industries, and the community-driven Trees for the Atherton and Evelyn Tableland (TREAT). The first two of these programs, and efforts by Private Forestry North Queensland (PFNQ, a regional plantation committee or 'forestry cluster') and the North Queensland Timber Co-operative (NQTC) have been aimed at restoring the timber industry.

The CRRP was a particularly interesting effort to restart the timber industry and to achieve other regional goals. This paper examines the performance of the CRRP in terms of its stated goals and other indicators, on the basis of a survey of program participants. In the next section, the nature of the program is outlined. Findings of the survey are then presented. Finally, some policy implications are drawn.

THE COMMUNITY RAINFOREST REFORESTATION PROGRAM

A consultancy was undertaken by Shea (1992) on behalf of 11 Far North Queensland Councils affected by the listing of the Wet Tropics of Queensland World Heritage Area (WTWHA). The consultancy report was designed to support a submission by the Councils to the State and Commonwealth Governments for a forestry program. The Shea report indicated that the Wet Tropics region had not been adequately compensated for the loss of the timber industry that was based on tropical rainforest logging, and recommended that the Commonwealth fund the establishment of a new timber industry under a structural adjustment package. Shea, drawing on earlier work by Kent and Tanzer (1983), argued that there was a strong case for the viability of this new timber industry. He identified 36,780 ha of land on the Atherton Tableland as more suited to forestry or catchment protection than cropping and pastures, but noted that landholders were unlikely to have sufficient capital to establish plantations and cover the cost of stand management until harvest age. The report advocated that government provide funding over a 30-year period to allow the planting of 1,000 ha per year of high quality hardwoods (Shea 1992).

The CRRP facilitated the establishment of mixed-species plantations of mainly native rainforest cabinet timbers on private land. The program was administered by the Department of Primary Industries – Forestry (DPI-Forestry) and more recently by the Department of Natural Resources and Mines (NR&M). Planting commenced in late 1992, as part of the WTWHA compensation package. Indeed, one of the motivating forces behind the program's inception was the need to overcome the social divisiveness of the World Heritage listing and associated industry contraction and loss of jobs. The program was implemented in 14 local government areas from near Mackay in the south, to Cooktown in the north, spanning environments ranging

from wet humid tropical lowlands to highland areas up to 800-1,600 m elevation which occasionally receive frost. Planting was undertaken on moderate and high-rainfall areas (averaging from about 1,000 mm up to more than 6 m per year) most of which previously carried rainforest and had moderately fertile soils (much being of basaltic origin).

The three levels of government combined to provide technical and physical assistance for farmers to plant woodlots. A mixture of assistance measures was provided, including provision of seedlings, site establishment, planting, and extension support. Work teams undertook planting and also early pruning and maintenance. These teams included supervisors with training in silviculture, and trainees under the Landcare and Environmental Action Program (LEAP). Some of those trainees were long-term unemployed persons, and a few were undergoing rehabilitation after incarceration. Training and employment was limited to six months for any individual. CRRP extension officers were available to assist landholders with advice on pruning, thinning, weed and pest control options, replanting, and also native forest management. Initially a major factor in determining species selection was the availability of planting material, which was constrained by the lead time required to establish nursery facilities and seedling production systems (FORTECH 1994).

A wide variety of tree species were planted in the first three years of operation. An initial list of 150 mainly native rainforest species was drawn up, but was progressively narrowed as information was gained about species performance. In the first year alone, 89 different species were planted (FORTECH 1994). It was envisaged by the program managers that about 20% of the area planted would be permanent environmental plantings, particularly in creekbank areas. By the end of the 1995-96 planting season, about 1,600 ha of plantations were established with more than 500 landholders participating in the scheme (Creighton and Sexton 1996). Planting continued until 1998, on a total area of about 1800 ha (Vize *et al*. in press). The program continued to operate in an advisory role until 2000 (Sexton 2000).

The total expenditure on the CRRP is difficult to estimate, but could have been as high as $15-20M, although a substantial amount was associated with administrative activities. The total cost during 1992-95 (the main planting years) for plantation establishment and for research, education and training is reported by Eono and Harrison (2002) at $5.75 M.

Governments involved in the project did not take any equity in plantations. Throughout the program, plantation establishment was heavily subsidised, with landholders initially only required to prepare and fence land prior to planting and to pay a small levy (about $50). This financial contribution required from landholders was increased during the program, but remained far less than the full plantation establishment cost. Excluding the LEAP training component, the full plantation establishment cost was of the order of $3,000 per hectare (Newport 2001).

Specific and Implicit Objectives of the CRRP

The CRRP had both commercial and environmental objectives. A multiple-use forestry concept was adopted, with four inter-related objectives, which were asserted to be of equal importance:

1. Development of a private plantation timber resource;
2. Arresting of land degradation following extensive inappropriate clearing;
3. Improvement of water quality in rivers and streams by establishing vegetative buffers; and
4. Training a work force to support rainforest plantation establishment (CRRP Management Committee 1993).

As well as the stated timber production and environmental goals, there appear to have been unstated goals in terms of regional compensation for withdrawal of timber resources from the timber industry, and social healing after the bitter dispute between the Commonwealth and the Queensland Government (Tisdell and Harrison 1999). Given increasing community concerns regarding protection of biodiversity, another implicit objective was to develop plantations which would assist in biodiversity conservation.

Prior to commencement of the CRRP, there had been little experience with growing native hardwood species in plantations in Queensland that could be used as a basis for management decisions such as species choice, site selection and silvicultural management. One of the implicit aims of the program was the establishment of a series of trials by which to measure growth of various tree species and mixtures across a range of sites. Information from these plots could then be used to select better performing species, identify appropriate sites for preferred species, develop management prescriptions for spacing, thinning and pruning, and improve understanding of the interactions between species in mixed plantations (Keenan and Annandale 1999).

'Community' Aspects of the Program

Apart from a few small plantings on local government land, the CRRP had no common property plantings, and was in essence a program of private small-scale forestry, mostly on commercial farms or rural lifestyle blocks. Much of the land on which planting took place was degraded from intensive cropping or grazing over many decades, on sloping and relatively fragile land in areas of high rainfall intensity. However, the program did have some genuine community aspects and differed considerably from traditional farm forestry programs in Queensland. These aspects included:

- Cooperative involvement of all three levels of government.
- Community initiation of and strong support for the program, mainly through 14 local government authorities.
- Active participation of local government in management of the program and in labour force brokering, cf. other forestry program were usually administered solely by the state government.
- A substantial workforce training and youth employment component.
- Almost exclusive use of native hardwood (rainforest and eucalypt) tree species, in contrast to the exotic conifers mainly used in industrial plantations in Queensland.
- Almost exclusive mixed-species plantings, cf. single-species plantings in other government-supported forestry projects.
- Government support for small-area plantings, initially of about 3-5 ha per farm.

- Inclusion of environmental plantings, cf. focus of earlier government-supported programs on commercial timber production.
- A recognised community compensation aspect following unilateral World Heritage nomination of the Wet Tropics rainforests by the Federal government.
- Active involvement by researchers in the Rainforest Cooperative Research Centre (from three universities and several government agencies) in various aspects of the program.
- Public annual conferences and farm visits to share experiences in the program.

RESEARCH OBJECTIVES AND METHODS

The overall objective of the research reported here has been to evaluate the performance of the CRRP in terms of both *stated objectives* and other program benefits or *implicit goals*. A number of performance criteria were developed to aid in this evaluation (Table 1).

Table 1. Research objectives and assessment criteria developed for evaluating the CRRP

Objective	Assessment criteria
Timber production	Total area planted by the CRRP
	Management quality (weeding, pruning and thinning)
	Plantation management and harvesting intentions
	Species likely to be harvested
Arrest land degradation	Types of sites planted
	Proportion of plantings on degraded lands
	Impacts of plantings on erosion and degradation
Improve water quality	Proportion of plantings in riparian zones
	Impacts of plantings on water quality
Job training and creation	Type and length of training
Biological conservation	Proportion of corridor and buffer plantings
	Changes in wildlife numbers
Scientific research	Evaluate species performance
	Species-site information
	Development of species growth models and stand yield models

A review was undertaken of published material and unpublished reports relating to farm forestry, soil and water conservation, timber resources and environmental conservation issues, with a particular focus on the Atherton Tableland, which was the most intensive area of CRRP planting. An initial research proposal was developed, based on the review and on discussions with a number of members of the Rainforest Cooperative Research Centre. A familiarisation visit was made to north Queensland in July 2000 to inspect reforestation sites, collect further publications and reports and obtain a list of CRRP landholders. Meetings were held with resource management officers in Cairns and Atherton, including staff of NR&M, North Queensland Regional Plantation Committee (NQRPC), PFNQ, and the Queensland

Forestry Research Institute (QFRI). The familiarisation trip, together with subsequent discussions, helped in understanding the nature of the CRRP and refining objectives of the research.

As a result of the familiarisation trip, it was decided to confine attention to a single stakeholder group (namely landholders) and to limit the survey area to two adjoining local government areas – Atherton and Eacham Shires – on the central Atherton Tableland. The main method of data collection was an interview survey of landholders participating in the CRRP. Personal interviews were chosen because as a group, the CRRP landholders had become 'survey weary' and it was believed that the level of response to a postal survey would be low. Further, the people who would respond to a postal survey might not be a representative sample of the CRRP landholders as a whole. The questionnaire (which included some open-ended questions) was developed and trialed informally on a number of experts on farm forestry as well as a number of farm foresters.

A total of 146 landholders participated in the CRRP within the study area. An initial contact letter was sent to each landholder. Interviews were undertaken during December 2000 and January 2001. A total of 72 landholders were interviewed, and at least one CRRP plot was inspected on each farm. A further three listed participants had never planted, and three declined to be interviewed. It was not possible to contact the remaining 68 landholders, mainly because they were away on holidays or had residences away from their land.

The survey data were analysed using a MicroSoft Excel spreadsheet package, and various frequency distributions, cross-tabulations and graphs were produced and interpreted. The Statistical Package for the Social Sciences (SPSS) was used to perform chi-squared tests and one-way analysis of variance on the survey data, where appropriate.

LANDHOLDER CHARACTERISTICS, ATTITUDES AND PERCEPTIONS

About one third of the landholders were aged 50 or above. Nearly all had secondary school qualifications or higher, and 36% had tertiary qualifications. About one third had a net annual income of over $60,000. The distribution of income earned from the property was bimodal, with more than half the respondents deriving less than 25% of their income from the land, and 41.7% deriving more than 75%. CRRP landholder property sizes averaged about 75 ha, but with nearly half of all properties falling in the 0-50 ha category and with 16% having an area of less than 10 ha.

Tree Planting Progress and Motives

Thirty four percent had planted less than 3 ha, and 24% between 3 and 10 ha. The median area was 3.5 ha, and the mean 6.05 ha. Seventy per cent had undertaken further tree plantings without any financial assistance from the government, while 36% had planted trees under other tree planting programs, though the average area of non-CRRP plantings was less than 2 ha.[1]

[1] None of these were plantings under the Plantation Joint Venture Scheme of the Department of Primary Industries.

As reported by Harrison *et al*. (2003), about one quarter ranked timber production as the primary motivation behind the decision to participate in the program, and another 20% ranked this as a moderately important factor. Other important motivations were creek bank stabilisation (the primary reason for 20% of respondents), land 'rehabilitation and conservation' (10%), aesthetics, provision of shade and shelter, and creation of windbreaks. Landholder reasons for participating in the CRRP differed from the four stated goals of government, with timber production and creek bank stabilisation being the only two announced goals receiving general support.

With regard to non-CRRP plantings, timber production was the most frequently cited motivation, followed by environmental conservation, windbreaks, aesthetics, creekbank stabilisation, weed control, shade and shelter, and scientific research. The notable difference between reasons stated by respondents for CRRP and non-CRRP plantings is the high ranking of windbreaks in the latter, indicating the importance of small fenceline and strip plantings.

Future Management Intentions for CRRP Plantings

More than half of the CRRP landholders stated an intention to manage their plantings to optimise a number of benefits, including timber production, soil and water management and conservation (Table 2). About 10% of participants intended to manage their plantings solely for one of the objectives of timber production, soil and water management or conservation. Approximately 15% did not intend to have any active role in managing their plantings. Management intentions can also be expressed in terms of proportion of area planted. By this criterion, the proportion of plantings for timber production as a dominant use increased from 14% to 24%. The implication is that those planting for timber, planted larger areas than those planting for other reasons.

Table 2. Landholders' management intentions for their CRRP plantings, by proportion of respondents and proportion of area

Management intention	Proportion of landholders (%)	Proportion of area (%)
Timber	13.9	23.9
Soil/water management	8.3	5.0
Conservation	11.1	7.9
A combination of reasons[a]	52.8	52
Ignore	13.9	11.2
Clear the area	0	0

a. A small proportion of respondents had both timber and environmental plantings, and these were included in this group.

About 36% of landholders did not intend to harvest any of their CRRP trees, while 47% intended to harvest all of their CRRP trees. On average, landholders expected to harvest about 70% of their CRRP area. The preferred harvest regime is clearly selective logging, followed by replanting. It can be assumed from the small area of CRRP plantation establishment and the preferred harvesting methods, that the contribution of the CRRP to the re-establishment of a timber industry will be

limited. Discussions with landholders suggested that attitudes to plantations and perhaps management intentions tend to change over time. Initial plantings were for timber production, but as the trees grew, the non-timber benefits tended to become more important to them. This perspective was particularly prevalent among those whose plantings received little maintenance. It was noted in the interviews that landholders would attempt to explain away poor maintenance or low growth rates, by switching the priority of their planting objectives.

Table 3 summarises landholder perceptions in response to an open-ended question about the most positive features of the CRRP. More than 50% stated that the CRRP handling of plantation establishment and maintenance was an important positive feature of the program, with over 30% of respondents claiming that no trees would have been planted without the CRRP. That the majority of establishment and maintenance costs were met by the CRRP was another important positive feature, as was the broad range of goals of the program. Other positives of the program included: saved time; positive and friendly people; range of species available to choose from; expertise of those running the program; demonstration and increased public awareness of forestry resulting from the program; and more productive land use by tree farming on degraded sites.

Table 3. Most positive features of the CRRP from the landholder's perspective

Feature	Number of times mentioned[a]	Relative frequency (%)[a]
Did the work	54	24.3
Trees wouldn't have been planted	32	14.4
Paid costs	31	14.0
Principles of program	26	11.7
Positive people	19	8.6
Range of species	14	6.3
Expertise	11	5.0
Saved time	10	4.5
Demonstration and public awareness	10	4.5
Nothing	7	3.2
Small area plantings	7	3.2
More productive landuse	1	0.5

a. Multiple responses were possible for this open-ended question.

Landholder criticisms of the CRRP in response to an open-ended question are reported in Table 4. Over 50% of respondents criticised the program for a lack of maintenance and follow-up work on plantations. Frequently criticised aspects of the program included: low job competence (particularly in relation to job trainees killing trees); poor choice of species; poor species-site matching; inappropriate planting methods, and lack of communication and information about how the program was progressing and tree management required. Other criticisms of the program included: disagreement with the goals of the program; landholder inputs being too high; trainee employment period being limited to six months; insufficient replacement of stock that had died; and low quality of the planting stock. It would

appear from some of these responses that not all landholders felt 'ownership' and accepted management responsibility of their CRRP plantings, perhaps due to the high amount of initial assistance by government.

Table 4. Landholder criticisms of the CRRP

Feature	Number of times mentioned	Relative frequency (%)
Poor maintenance or lack of follow-up	53	19.1
Killed trees: were incompetent at their job	33	11.9
Species choice	32	11.5
Planting method	29	10.4
Communication and information	26	9.4
Species/site matching	25	9.0
None	17	6.1
More than could handle	17	6.1
Planting stock	17	6.1
Job focus	7	2.5
Environmental focus	7	2.5
Inputs too high	7	2.5
Replacement	4	1.4
Sort term of trainee employment	3	1.1
Timber focus	1	0.4

TIMBER PRODUCTION PROSPECTS OF THE PROGRAM

Given that a major motivation for the CRRP was the re-establishment of a timber industry in north Queensland, it is relevant to examine the likely impact of the program in developing a future timber resource and encouraging other production plantings. A number of questions shed light on the prospects for timber production (in addition to the information on area planted and management intentions presented above).

Area Established Under the CRRP, Follow-on Plantings and Harvest Intentions

Potentially, a substantial amount of timber could be produced from the CRRP planting area of about 1800 ha (about one quarter of which is in the Atherton and Eacham Shires). Original stocking densities were about 600 to 700 stems per hectare. Initial death rates after planting reported by respondents varied considerably between sites, ranging from 1% to 2% at some locations, to as high as 80-90% at others, with an average of 27%. Reasons for mortality included: overly dry or wet weather; species not suited to site; plots overgrown with weeds, and cattle damage. Replacement of trees was common for stands which had mortality rates greater than 20%. However, losses amongst these replantings were also high at around 30%. As a result, stocking densities on some locations had fallen to well below a desired level for timber production.

As noted above, on average landholders expected to harvest about 70% of their CRRP area, and 47% intended to harvest all of their CRRP trees. About 18% of

respondents believed that none of their plantings were performing well enough for any timber to be harvested. While 70% of respondents had undertaken further tree planting without any financial assistance from the government, the additional areas were too small to provide much commercial timber.

Species from which Timber Production is Most Likely, and Expected Harvest Age

Nearly half of the respondents cited Queensland maple, silver quandong, Queensland kauri and eucalypt species as likely to be harvestable. Other commonly mentioned species included acacias, hoop pine, silver ash, silky oak (northern and southern species) and West Indian cedar. In non-CRRP plantings, rainforest species were the clear choice, accounting for over 60% of plantings (Table 5). About 20% of non-CRRP plantings are of native hoop and kauri pine, while small areas have been planted to eucalypts and exotic conifers.

Table 5. Species planted in non-CRRP tree plantings

Species group	Proportion of landholders (%)	Proportion of area (%)
Eucalypts	12.9	6.5
Exotic pines	6.5	7.0
Native pines	12.9	22.9
Rainforest species	64.5	63.5

Timber from mixed rainforest plantings could begin to be harvested as the faster growing species reach early maturity in about 10 to 20 years after planting. High value cabinetwoods are not predicted to become available till about 50 years after planting, which led to the prediction (Shea 1992) that timber harvesting of the plantations is unlikely to begin in earnest for 50 years. More recent estimates suggest an earlier harvest age for cabinet timbers of 30 to 50 years (Russell *et al*. 1993, Herbohn *et al*. 1999). There is still considerable uncertainty about harvest age for many of the species and sites, and indeed CRRP plantings will provide valuable information in this regard.

Scale of Timber Production in Relation to Timber Processing Infrastructure

A major determinant of the marketability of the CRRP plantations will be the success of the project in achieving market scale. Shea (1992) envisaged planting levels about 1,000 ha per year for the next 30 years, for the resource to be large enough to develop the critical mass needed to support a local processing industry and timber exports. An annual turnoff volume of the order of 10,000 m^3 would probably be a minimum throughput to warrant processing facilities. At a mean annual increment of 5-10 m^3, this would require a planted area of 1000-2000 ha within a mill catchment area. The total area planted under the CRRP on the Atherton Tableland falls short of this threshold, the dominant species are not well known to the trade, the mixture of species creates additional milling difficulties, and some of this area will not be harvested. Hence the CRRP in itself is not of sufficient scale to support a fixed-site mill, though opportunities for portable milling (circular or bandsaw) will arise.

Plantation Management Issues and Timber Quality

The quality of plantation management, and impacts this has on timber quality, can be expected to affect the development of any new timber industry. It is the belief of some researchers that only the well-managed (well pruned and appropriately thinned) plantings will be attractive for harvesting (FORTECH 1994). As market demand for high-quality sawn or veneer products from plantations is likely to increase, ready markets should be available for CRRP timber, provided an adequate volume and suitable quality are achieved. Markets for commodity and lower quality timber products are far less certain, hence it is important to adopt silvicultural regimes that maximise the production of high-quality logs (FORTECH 1994). Table 6 reports the condition of CRRP plantings as assessed by respondents and verified visually by the interviewer. There is an even spread of plantings in the categories of 'very well maintained', 'well maintained' and 'weeding/pruning required', with only a small proportion of the area in the 'overgrown/unmaintained' category. However, it can be expected that many of the 'weeding/pruning required' plantations will move into the lower condition category if appropriate management techniques are not applied soon. The differences between the proportion of area and proportion of landholders indicates that landholders with larger plantations manage them to a higher standard.

Table 6. Condition of CRRP plantations by proportion of respondents and area

Condition of plantation	Proportion of landholders (%)	Proportion of area (%)
Very well maintained	19.4	24.8
Good condition	20.8	30.9
Require maintenance	43.1	33.7
Unmaintained	16.7	10.8

Contribution of the CRRP to Knowledge about Growing Non-traditional Species and Successful Plantation Systems

When the CRRP commenced in 1993, it was against a backdrop of scepticism from many foresters formerly involved in rainforest logging operations. Few attempts had been made to grow native tropical species under plantation conditions, and those attempts had produced far from spectacular results. Many foresters had expressed concerns about both the length of time it was expected to take trees to reach a merchantable size, and the likely inferior quality of plantation-grown timber relative to that growing in native forests. Little or no information existed about the likely growth rates of rainforest and many eucalypt species under plantation conditions. Likewise, there was little information about successful species mixtures, and effective planting and establishment methods for rainforest species (Herbohn *et al*. 2000a). Therefore many questions were posed by those interested in growing rainforest cabinet timbers in plantations. Could the higher market value of these timbers compensate for their slower growth, now that timber from native forests is no longer available? If so, which species should be planted? What are the best sites? What plantation design should be used? What are the most successful plantation management practices for these non-traditional species?

Practical research to address these questions requires long-term plantation trials. A number of plantations were established in north Queensland in the past by DPI-Forestry, some of which are now over 60 years old. These provide baseline data on growth rates of commercially attractive trees but it is clear that higher growth rates might be possible if planting material of higher genetic quality or improved plantation establishment and management methods were used.

A large number of native species were planted in the CRRP, providing information about their performance under a range of sites and managements. About a third of the original 150 species were selected for further consideration across the region (Creighton and Sexton 1996). Based on outcomes of CRRP rainforest species plantings, more detailed research has been conducted on a small number of these species having relatively high growth rates and high timber quality.

Estimates of growth rates and likely harvest ages, along with information about species mixtures, is of value to a number of groups. These groups include farmers who are interested in planting rainforest trees, forest service staff who advise on tree planting and farm forestry activities, and financial modelers and economists who wish to predict likely returns to individual farmers and regional economic benefits (Herbohn *et al*. 2000a). Given the lack of historical data on almost all the rainforest species, the estimates produced are a convenient mechanism through which to collate and summarise current expectations about likely performance of rainforest cabinet timbers under plantation conditions.

The capacity of forest policy-makers and managers to predict plantation growth and yield is critical for many strategic and operational purposes. At a strategic level, yield models coupled with financial models permit assessment of whether an investment in forestry should be made at a particular site and which species should be grown. At an operational level, yield models can guide decision-makers toward optimal planting densities, and be used to refine the timing and intensity of silviculture and harvesting operations (Vanclay 1994).

STATISTICAL ANALYSIS OF SURVEY FINDINGS (CHI-SQUARE TESTS AND ANOVA)

Cross-tabulations were obtained for a number of survey variables, in terms of frequencies of responses, and the relationship between various pairs of variables was examined using chi-square tests of independence. In essence these tests compare the null hypothesis of independence in population proportions against the alternative hypothesis that the variables are related. Where the probability is less than 0.05, the null hypothesis of independence is rejected, and it is concluded that these variables are related. Table 7 reports probabilities – under the hypothesis of independence – obtained through chi-squared tests, using the Statistical Package for the Social Sciences (SPSS). Most tests reveal no relationship between variables. Chi-square probabilities indicate a positive relationships between plantation condition, and education and income. Also, the proportion of area the landholders expect to harvest

appears to be related to size of CRRP plantings; landholders that have established larger plantations expect to harvest a greater proportion of these plantings.[2]

Table 7. Cross tabulations and chi-square tests of independence on some survey variables

Variable 1	Variable 2	Chi-square probability
Plantation condition	Age	0.5527
	Education	0.0105
	Income	0.0280
	Income from property	0.3061
Proportion expecting to harvest	Income	0.8914
	Education	0.1165
	Age	0.8975
	Income from property	0.9147
Hours spent on plantings	Income from property	0.4439
	Income	0.5593
	Education	0.2630
	Age	0.8835
Other tree plantings	CRRP plantation condition	0.3637
	Proportion expecting to harvest	0.4933
Area planted	Proportion expecting to harvest	0.0319
	CRRP plantation condition	0.4082

One-way analysis of variance (ANOVA) was also conducted on a number of survey variables. Test statistics which are statistically significant at the 5% level are reported in Table 8. These tests compare plantation condition with time spent on plantation management (hours/ha) and proportion of area for which harvest is expected. CRRP plantings that are in very good condition have significantly greater labour input than those which needed weeding and pruning or are overgrown. The expected proportion of area to be harvested differs significantly between all four plantation condition states.

Overall, the statistical analysis reveals a close association between harvesting intentions, and plantation size and management effort, with larger plantations more typically being managed for timber production. A reservation about the statistical findings is that some bias may have arisen because of the group of CRRP participants not available for interview at the time of visits to the Atherton Tableland (some of whom live off-farm). It is possible that a smaller proportion of these intend to harvest their trees, although the relationship between plantation size, intensity of management and harvest intentions may still hold for these landholders.

[2] Some doubt arises concerning the reliability of the chi-squared tests because about 25% of cells had expected frequencies of less than five.

Table 8. One-way ANOVA of survey variables

Factor	Condition of planting	Mean	95% confidence interval for mean	
			Lower Bound	Upper Bound
Labour input (hrs/ha)	Very good	82.14	44.32	119.96
	Good	52.60	9.55	95.64
	Needs work	14.58	2.31	26.84
	Overgrown	18.58	-5.35	42.52
Proportion expected to be harvested	Very good	90.00	74.47	105.52
	Good	74.20	50.84	97.55
	Needs work	42.74	25.56	59.91
	Overgrown	24.16	-0.62	48.95

CONSERVATION AND TRAINING BENEFITS

The CRRP has played a role in arresting land degradation, improving water quality, protecting conservation values, and providing training and employment, each of which are now considered.

The Role of the CRRP in Arresting Land Degradation

Limited information is available to assess the contribution of CRRP plantings in arresting land degradation and erosion. Impacts can be inferred from a number of landholder responses. An evaluation of the land use prior to the establishment of CRRP plantings aids in identifying land quality and management issues. About 20% of CRRP landholders indicated that prior to planting trees the land was degraded or weed-infested and had little production (Table 9). The proportion in terms of area planted is also around 20%. Few landholders reported that their plantation had been established on high quality cropping land. About 25% of CRRP plantations were established on unused creek banks (though only about 13% by area). Nearly half of the CRRP plantings (and 70% by area) were established on land which had previously been used for grazing of dairy or beef cattle.

Table 9. Land use prior to CRRP plantation establishment

Main previous land use	Proportion of landholders[a] (%)	Proportion of area[a] (%)
Grazing/dairying	45	67
Cropping	7	2
Degraded/weed infested land	23	18
Creekbanks	25	13

The majority of plantings are on high quality soils (54% of landholders), compared with moderate (28%) and low quality soils (20%). When assessed in terms of area planted, there is approximately a uniform area distribution across the three soil quality categories. Although a small proportion of plantings (19% by frequency and

27% by area) occurred on slight slopes, most plantings occurred on moderate to steep slopes. The distribution of slope types (slight, moderate, steep)[3] was less uniform when assessed in terms of area planted, indicating larger plots were typically on steeper land. Overall, it can be concluded that plantings tended to be on soils of reasonable quality, but on sloping grazing land previously used for grazing and subject to degradation, hence the plantings may have had a positive impact on land protection.

The Role of the CRRP in Improving Water Quality

The environmental dimension of CRRP plantings on water quality includes impacts on protection of water quality, reduced sedimentation of watercourses, protection against streambank erosion, increased opportunities for recreation (i.e. fishing), and improved aesthetics of waterways. Herbohn *et al*. (2000b) reported that water quality appears to have improved in regions with CRRP plantings, with supporting evidence from scientists and local port authorities. Also, improvements in water quality appear to have had a positive impact on the value of waterway aesthetics and perceived recreation opportunities along waterways (Herbohn *et al*. 2000b). Qureshi (1999) noted the major benefits of riparian revegetation in the coastal wet tropics, concluding that trees aid in creek bank stabilization, but that tree cover can leave the soil surface exposed and vulnerable to run-off, and is not favoured by farmers who use cropping machinery near creeks. Eono and Harrison (2001) noted positive benefits in terms of water yield and quality due to CRRP plantings.

About 65% of CRRP plantings had a riparian (though not necessarily creekbank) component. The total area of creek bank revegetation by the landholders surveyed was 159 ha or 37% of the total CRRP planted area. The majority of landholders (80%) reported no effect from tree plantings on the riparian environment. A few noted an increase or decrease in weeds, and a few noted improved water quality. The distributions by proportion of landholders and area represented are almost identical. It is possible that given the early stage of CRRP plantings, the effects on the riparian zone are yet to be realised.

Biodiversity Conservation Values of CRRP Plantings

Keenan and Kent (1997) reported that mixed-species plantations can have high biodiversity values, recording between 22 and 181 plant species in plantations on the Atherton Tableland. Many CRRP tree plantings are now well-established and beginning to attract birds and other wildlife. Kanowski *et al.* (in press) found that numbers of rainforest birds are higher (though not significantly) in CRRP mixed species plantation than in pasture sites, and also found evidence that the number of forest type birds (not rainforest specialists) is higher. Wildlife records collected by CRRP participants contributed to research being conducted by NatureSearch[4]. In

[3] The classification of soil quality and slope class is subjective rather than based on scientific measurement.

[4] NatureSearch is a Queensland Environmental Protection Agency system which is enlisting members of the community to gather information on Queensland's flora and fauna. Wildlife records are stored on the WildNet system where they can be utilised by managers, planners, biologists and naturalists for a range of conservation purposes.

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terms of wildlife numbers, about 70% of landholders noticed an increase associated with their CRRP plantings, and nearly 30% reported a large increase. Species level identification was poor, but generally there was an increase in avifauna and some small mammals.

About 61% of CRRP plantings were reported by landholders as forming part of a continuous or stepping-stone vegetation corridor network. More than half of the plantings (55%) adjoin a forested area (hence taking the form of buffer plantings), and another about 20% are within one kilometre of a forest area.

Training and Job Creation

Training was provided through the Landcare and Environmental Action (LEAP) program during the early stages of the CRRP. Shepherd (1993) noted that the formal training component comprised over 25% of the total time of recruits, and that the training provided participants with useful, recognised skills that would be attractive to employers involved with land-based natural resource management. He further commented that participants were constantly developing new vocational skills in the field while working alongside their supervisor. The training attempted to develop in the young recruits a work ethic and an understanding of contributing today to a goal many years off. Past experience with rural labour scheme reveals that about 60% of trainees find other jobs or undertake further education, and Shepherd as training manager expected a similar rate for CRRP trainees (Eono 2003). This limited information suggests that job training and an improved work ethic may have been a positive social benefit of the CRRP.

It was not possible to investigate job creation and spillover effects of the post-establishment phase in any detail. The prospects of job creation from reforestation is limited as experienced labour is not really necessary; with adequate advice most workers can readily learn the techniques used in forest establishment and maintenance. In most instances of private forestry establishment and management in north Queensland, the landholders carry out the work themselves. The number of hours spent on the CRRP plantations by landholders and family members varied considerably, with 47% spending no time over the past year on plantation maintenance, and the average time being 36 hours per year. Labour had been hired for plantation work by 31% of respondents. A total of 39 people had been hired for a total of 1051 hours or an average of 50 hours work per hiring landholder, to undertake weeding, slashing, spraying and pruning.

DISCUSSION

The CRRP has been an imaginative if expensive experiment in growing rainforest and eucalypt trees on private land. Due to the relatively small area planted, the four stated objectives could not be said to have been achieved to any substantial level, and it could be argued that a large amount of taxpayer funds was spent for a

[4] (continued) Information about the wildlife using CRRP plots, for instance, will help demonstrate how valuable these plantings can be as wildlife habitat and help in developing guidelines for future farm forestry plantations if attracting wildlife is an important motivation for the landholder.

relatively small plantation area. However, the program has provided a great deal of experience in growing very-high-value non-traditional native rainforest species in small woodlots, and has generated a great deal of interest among landholders in growing these species. Within the limits of the scale of plantings, it had positive land protection and perhaps wildlife habitat benefits, and provided a platform for skills training and rehabilitation of a disadvantaged community group.

What policy lessons can be drawn from the CRRP? It seems clear that the benefits of replicating the program would be marginal, but that the findings about growing rainforest cabinet timbers could be put to practical use. These species are strongly favoured by landholders, and can perform well in plantations provided the stand management is sound. While there is still much to be learnt about desirable species mixtures and field layout arrangements, some planting systems have been identified as of high promise, e.g. alternate rows of Queensland maple and silver quandong or eucalypts. The small scale of plantings to date is not sufficient to attract new technology into hardwood processing. Lack of silvicultural advice is a clear limitation on further plantings.

It may be that policy measures could be implemented at relatively low cost which would have a strong stimulatory effect on tree planting and associated resource production and environmental benefits. Larger plantings than under the CRRP would be desirable to gain economies of scale. Aspects of government support could include ensuring access to high quality seedlings of the most financially viable native species, provision of extension service with regard to site-species matching and silvicultural management, and perhaps in the future, some assistance with timber marketing. Clearly, a substantial financial input from landholders would be required, and would probably lead to greater commitment to stand management.

A number of general conclusions for forest industry development can be drawn from CRRP experiences. A major reason for failure of plantings is the tendency to underestimate the level of inputs required. Program co-coordinators and participants need to develop mechanisms for focusing of follow-up maintenance, rather than simply on achieving planting area targets. Where timber production is a priority, the focus should be on growing a limited number of recognised brand-name species, which have a proven ability to be grown in plantation situations.

Investigation is needed into the future evolution of the forestry industry. In particular, a focus is needed on economically sustainable ways of harvesting small quantities of high value timbers. Regional natural resource management (NRM) planning needs to plan for sufficient planting to provide for a sustainable industry as well as acknowledge and take advantage of the benefits provided by reforestation to the natural resource management objectives. There is a need for policy-makers to provide opportunities for landholders to derive benefits from the non-timber aspects of their plantings, for example for carbon credits. This could include provision of free trees under a Land for Wildlife arrangement, rate rebates for areas planted, and discounts on herbicides or fencing equipment. The bundling up of a number of objectives, such as by the CRRP, can result in conflicting objectives.

The CRRP provides an example of a form of community forestry in a tropical rainforest setting in a developed country. The program was innovative and experimental, and the benefits not what were expected at the time the program was designed. The long-term benefits are difficult to determine, but landholder interest in planting tropical hardwood timbers has certainly increased in north Queensland.

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